A NEW PROBLEM

To Discover the

Longitude at Sea,

BY THE

Same OBSERVATION,

AND

With the ſame Certainty, as the
LATITUDE is:

TOGETHER

With the Tranſlation of the PROBLEM
into Latin.

716/4 f. 5

By RICHARD LOCKE.

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A Paper printed in the *London-Evening Poſt*,
January 24, 1751.

TO THE

Hon. the COMMISSIONERS appointed to inſpect the Longitude, and to the PUBLICK in general, this Problem for finding the Longitude at Sea is humbly ſubmitted by the Author,

RICHARD LOCKE.

WHEREAS the Author having made three ſeveral Voyages to *America*, with a View, in a great Meaſure, to diſcover the Longitude: The firſt was with a good Watch and an Inſtrument to take true Time, which he did to a great Exactneſs: The ſecond was by an Eclipſe of the Moon, with an equal Certainty; but neither of theſe Methods can be depended upon at Sea: And the third, by a Problem, by which the Longitude, in the Dead Reckoning, is corrected by the ſame Obſervation that the Latitude is, and to the ſame Certainty, without any Regard to Lee-Way, Currents of the Sea, or Variation of the Compaſs: And becauſe it is a Problem of univerſal Benefit to Mankind, I ſhall communicate the practical Part to the Publick, reſerving the Explication and Demonſtration of this, and the other two Methods, to a more convenient Opportunity.

There are few that uſe the Seas, but know how to correct the Latitude in the Dead Reckoning, by an Obſervation: As, if the Latitude, in the Dead Reckoning, is leſs than in the Obſervation, they add the Difference to the Latitude, and hence find the Longitude, by adding the ſame proportionable Difference; and if leſs, by ſubſtracting in both Caſes; which is very erroneous, and quite contrary to the Truth: For if the Dead Reckoning is found leſs than in Obſervation, 'tis plain the Courſe was taken too much, and Diſtance too little, by Reaſon of the Lee-Way, Currents of the Sea, or Variation of the Compaſs; ſuſtract therefore the Difference from the Longitude, this will give the true Courſe anſwering to the obſerved Latitude, and hence the true Longitude; but if leſs, as when the Courſe is too little and the Diſtance too much, from the ſame

Cauſes, add the Difference to the Longitude, and it will give the true Longitude and Latitude. To inſtance in Numbers; ſuppoſe, in the Dead Reckoning, the Latitude is found to be 10 Leagues and the Longitude 15, but by an Obſervation the Latitude is found 15, ſubſtract the Difference from the Longitude, and adding it to the Latitude, it will make the Longitude 10, and Latitude 15; this, according to the uſual Way of Correction, would have made the Longitude 20: But if the Latitude in the Dead Reckoning is 15, and only 10 in the Obſervation, and the Longitude 10, add the Difference to the Longitude, and the true Latitude is 10, and Longitude 15; which, according to the common Correction, would have been only 5, *probatum eſt*, and which may eaſily be demonſtrated by the Problem. And if any are deſirous of ſeeing the Explications and Demonſtrations of all the three Methods, they may be ſatisfied by the Author, a Clergyman, lodging at Mr. *John Bray*'s, Founder, in *Hoſier-Lane*, *Weſt-Smithfield*: And he hopes, that as he hath freely thus imparted his Scheme to the Publick, that if it is found true in Practice, as it is in Speculation, and as he hath found it in Practice himſelf, he ſhall be entitled at leaſt to ſome Advantage of the promiſed Reward; as it hath been very difficult and expenſive to him in the Diſcovery, by Study, Travelling, and hindering him in his temporal Affairs; and he further deſires thoſe who may make a Trial of it, to be careful in working up their Latitude and Departure, and eſpecially of making Obſervations; for, as much as they miſs in obſerving the Latitude, ſo much they will miſs in the Longitude, and no more, as he hath experimentally found, in the laſt Voyage to *America*. *Laus ſoli Deo.*

Jan. 23,
1750-1.

RICHARD LOCKE.

INTRO-

INTRODUCTION.

HAVING put out an Advertiſement in the *London-Eveniug Poſt* of *January* 24, 1751, concerning a new Problem to find the Longitude at Sea; wherein I only mentioned the practical Part, and what I had found to be true, in a Voyage from *Virginia* to *England*, without giving any Explication or Demonſtration of the Problem, reſerving theſe Things for a more convenient Opportunity: But finding that this Method could not give that Satiſfaction to the Publick, as muſt neceſſarily be expected in a Matter of ſo much Conſequence to the World; and beſides this Diſcovery of a Method to find the Longitude at Sea, capable of Demonſtration, is what hath for many Ages, employed the ingenious and inquiſitive Part of Mankind, tho' they generally looked too high, by ſearching for that amongſt the Stars which can only be had here upon this Earth. Led by theſe Motives, I was reſolved to publiſh the Explication and Demonſtration of this Problem, and let it take its Fate in the World, as every one is at Liberty to examine it; and this will put an End to thoſe Difficulties, and eſpecially Queſtions that have been propoſed to me about it; for now it muſt ſtand or fall, as by Time and Experience it ſhall be found true, or falſe.

The great Reward promiſed for a Diſcovery of it hath encouraged many ingenious Attempts, and no doubt but very much improved the practical Part of Navigation; for a Proſpect of Reward is a certain Spur to Induſtry; and I cannot deny but that it was a great Inducement to me, to be at ſome Expences, and to bear with thoſe many Difficulties, as I muſt neceſſarily be expoſed to, in Study and Travelling to make thoſe Experiments; as I ſhall now freely impart to the World; and only reſerve to myſelf, the firſt and laſt Shift of Life, which is Hope.

Having always a great Deſire to Mathematicks, from my firſt ſtudying them in a College here in *England*, I applied myſelf to the Study of the Longitude, and publiſhed a Pamphlet of it, ſome Years ago; after that I was introduced in the Company of the famous Mr. *Halley*, and I propoſed the Scheme to him; he aſked me, if I had been to Sea to try it? I told him I had been in *Italy* by Sea; but not with a Deſign of diſcovering the Longitude: I was throughly ſatisfied with the Queſtion; and deſigned then not to concern myſelf any more about it; but meeting with ſome Diſappointments in the Affairs of Life, which is but the common Fate of all Mankind, I was again reſolved to go abroad, and try my Fortune in other Parts of the World; and in a great Meaſure with a View to make ſome new Diſcovery about the Longitude.

The firſt Voyage that I made was from *Portſmouth* to *Antigua*, as Chaplain of a Man of War; I had then no other View of diſcovering it, but by a very good Watch, and a double Equinoctial Dial, to take true Time, by which I could find the Time at Sea as well as at Land. At *Portſmouth* I put my Watch to the true Time of the Sun; and made no other Obſervations, before we came into 29 Degrees of Latitude: I firſt made the Obſervation for Latitude, and by the ſame Inſtrument, ſome Time after, I took the Hour of the Day, and found it 42 Minutes after 2 o'Clock; the Watch ſtood then at 14 Minutes after 4, the Difference of Time was 1 Hour, 32 Minutes, equal to 23 Degrees of Longitude Weſt, as the Time of the Day was before the Time of the Watch; and when we made *Antigua*, I found the Difference between the Watch and obſerved Time to be 3 Hours, 56 Minutes, equal to 59 Degrees of Longitude Weſt: By this Trial I found the Longitude might eaſily be diſcovered by this Method, if it was poſſible to find a regular Movement to diſcover true Time; but this hath been hitherto impracticable, and I am apt to think will always be ſo.

Some Time after this I made another Voyage to *America*, and lived for ſome Years at a Town called *Lancaſter* in *Penſilvania*, and, *February* 13, 1747, I obſerved a total Eclipſe of the Moon, which began there a little after 10 o'Clock, and ended about as much before 2, the 14th Day in the Morning; hence I concluded, that the Middle of the Eclipſe, or Full Moon, was about 12 o'Clock, or Midnight; in this Eclipſe at *London* I found, by Tables made for that Meridian, that the Oppoſition, or Full Moon, was, *February* 14, at 52 Minutes after 4 o'Clock in the Morning. Theſe 4 h. 52 m. in Time, are equal to 73 d. 15 m. in Degrees, which anſwers very near to the computed Difference, which is reckoned to be 75 Degrees, equal to 5 Hours in Time; but this Method cannot any way be depended upon to find the Longitude at Sea, as there are ſo few Eclipſes of the Sun or Moon. Some, indeed, have imagined, that if the Place of the Moon could be calculated and obſerved to a great Exactneſs, it would be a great Help towards the Diſcovery of the Longitude at Sea; but even this would be impracticable, and not to be depended upon; for the Moon doth not always appear; and its Motion or Receſſion from the Sun is ſo little, that it doth not amount to above 30 Seconds, equal to 2 Minutes in Time, in one Hour, which is equal to 15 Degrees in Longitude, and that is but 2 Seconds for 1 Degree, that it is impoſſible by any Inſtruments to make ſuch nice Obſervations, eſpecially at Sea, where the Ship is always in Motion: And there are no other Obſervations, by which it might be done, unleſs by the Satellites of *Jupiter*, and theſe are inviſible without the Help of Teleſcopes, which are in that Caſe wholly uſeleſs at Sea.

Wherefore we muſt neceſſarily have Recourſe to mechanical Principles, and as Diſtances in Surveying, and all mechanical Operations, are meaſured on Land; ſo by proper Methods it might be done to as great Certainty, or at leaſtwiſe as much as ſhall be neceſſary, at Sea. There have been ſeveral Methods invented and made Uſe of; but what ſeems to be the beſt, is that of the Log-line and Half-minute Glaſs, commonly uſed by the *Engliſh*; and by this Problem it is demonſtrated, that if the true Diſtance is given, the Longitude, or Eaſting and Weſting, may be found with as much Certainty, as the Latitude is by Obſervation, without any Regard to the Variation of the Compaſs, Lee-way of the the Ship, or Currents of the Sea; becauſe it is corrected by the ſame Obſervation, that the Latitude is. The Demonſtration is founded on the Principles of *Euclid*.

Upon theſe Conſiderations, and meeting with ſome Diſappointments, the common Accidents of Life, it put me upon a third Trial of finding the Longitude in a mechanical Way; and having got an Inſtrument made ſomething like a ſinical Quadrant with moving Labels, by which Triangles both Plain and Oblique may be calculated, much ſooner than by Logarithms or Scales, and much better, as I thought, than by the Tables of Latitude and Departure; I was reſolved to make a third Voyage to *America*, with a Deſign of ending my Days there; but God, in his good Providence, was pleaſed to order it otherways. In the Voyage I wholly depended upon the Diſtance run, without any certain Method of correcting it; only allowed 50 Feet between each Knot, and the Glaſs to be 30 Seconds. Upon aſking, how the Log-line was divided? I was told by 45 Feet, and the Glaſs was 30 Seconds, to keep the Dead Reckoning before the Ship; and from hence I concluded to ſubſtract 10 Miles out of every 100, and 100 Miles out of every 1000, which is according to the Proportion of 45 : 50. A little before we made the Land, I told the Mate that we were 960 Leagues Weſt from the *Lizzard*; he ſeemed to take little Notice, and rather laughed at it; but a Surgeon on board the Ship hearing me, laid a Bottle of Wine upon the Reckoning, and got it: The Journal I have by me, I made it according to their Diviſion of the Log-line to be 3300 Miles from the *Lizzard* to *Cape-Henry* in *Virginia*; and ſubtracting 100 out of every 1000, made it juſt 3000 Miles, or 1000 Leagues. The Reckoning was ſo exact, that they gave it out in *Virginia*, that I had found the Longitude, tho' I had no other Method at that Time, than what is mentioned before, which was wholly to depend upon the Diſtance run, allowing the Diviſions of the Line to be 50 Feet, and the Glaſs 30 Seconds.

I was ſettled in a Pariſh in *Virginia*, but my Health was ſo much impaired by Age, and the Change of Climates, that I could not well perform ſuch long tedious Journies, as are required in their Pariſhes; and meeting with other Difficulties and Perſecutions, and eſpecially the great Scarcity of Food and Rayment; beſides the Number of Negroes that are there, which has made it a mere Neſt of Thieves, and renders the Country very diſagreeable; and having at the ſame Time diſcovered this Problem, I thought it would be very envious in me to conceal a Thing of ſo much Benefit to the Publick; as it was by the Goodneſs of God freely diſcovered to me. Upon theſe Conſiderations, I thought it was better to come Home than to live in Miſery there; and in the Paſſage, to make a thorough Trial of it, I only took the Diſtances as entered in the Log-Book, without examining into the Glaſs or Log-line, not doubting but that, as I corrected the Latitude by Obſervation, ſo I could correct the Longitude by this Problem, which I found to anſwer beyond Expectation; for I made it juſt 3003 Miles from *Cape-Henry* to the *Lizzard*, or 1001 Leagues, as I have now the Journal by me, which was but 3 Miles Difference, between going and coming, tho' I was ſenſible, by the Obſervations of Latitude, that their Log-line and Half-minute Glaſs were very much out, as well as keeping bad Courſes.

And by this laſt Voyage, I find that not only the Latitude is corrected by the Obſervation, but alſo the Longitude and Diſtance are corrected by this Problem, to the ſame Certainty; as I made no Allowances for the Diſtance run, as in the other Voyage. This is what is evident in Speculation, and will appear ſo upon a cloſe Examination of the Problem; but I cannot expect, that the Truth and Uſefulneſs of it ſhould depend upon this one Voyage; but upon the general Experience and Practice of the whole World.

I muſt own I was adviſed not to publiſh it, before I had ſome Promiſe of a Reward; but to whom could I apply, that would take any Notice of a bare Propoſal, after ſo many Attempts as have been made, and all to no Purpoſe? And if this ſhould prove true in Practice, as it is in Speculation, and as I have found it in Practice, I doubt not of the Generoſity of my Country; they certainly will allow me ſome Premium, or it will be a great Diſcouragement to Poſterity, ever to attempt any Thing for the publick Good.

Speramus quæ volumus, ſed quod accederit, feramus.

I cannot deny but formerly I publiſhed ſeveral Attempts about the Longitude; but I had not then that Experience, and Trial, as I have ſince had in this, tho' I always imagined, that it might be done ſome ſuch Way, as I publiſhed it in a *Miſcellany of Mathematicks*; wherein I attempted the Squaring of the Circle, and found out a new and nearer Proportion than of 7 : 22, which is 8 : 25, or that 3 Diameters $\frac{1}{8}$ are equal to the Circumference, and a Problem to double, triple, *&c.* the Cube, the Correction of

Time, and in it likewiſe a Method to find the Diſtance run, without the Help of an Half-minute Glaſs, *&c.* And this Diſtance run, and a good Obſervation of Latitude, are all the Requiſites that are neceſſary in Navigation; for every Thing elſe is corrected by this Problem, to a mathematical Certainty, and even the Diſtance by a good Obſervation. But Time and Experience tries all Things. *Laus Deo.*

Richard Locke.

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Explication and Demonſtration of the PROBLEM to find the Longitude at Sea, by the ſame Obſervation, and with the ſame Certainty, that the Latitude is. By the Author,

RICHARD LOCKE.

IF the Longitude could be found by Obſervation, without an imaginary or Dead Reckoning, as the Latitude is; yet it would be neceſſary always to keep this Reckoning at Sea, by Reaſon of cloudy Weather, that ſometimes Obſervations cannot be made for Weeks together. The Dead Reckoning is the Eſtimation of the Ship's Way, with reſpect to Longitude and Latitude, by Help of a Log-line and Half-minute Glaſs to meaſure the Diſtance run; and a Compaſs to find the Angle of the Courſe.

In order to calculate this Reckoning, they form an imaginary Right-angled Triangle, the Perpendicular to repreſent the Meridian or Difference of Latitude, the Baſe, the Longitude or Departure, which properly is the Eaſting and Weſting from the Meridian, and the Hypothenuſe the Diſtance run.

Let ABC (Fig. 1.) be the Triangle, AB the Difference of Latitude, BC the Longitude, and AC the Diſtance run.

In this Triangle the Angle ABC, made by the Latitude AB and the Longitude BC, is always right; let their Courſes and Diſtances be never ſo intricate, ſo as to paſs and repaſs the Meridian. The Perpendicular, or Latitude AB, is found by Obſervation; the Diſtance run AC by the Log-line, and Half-minute Glaſs, which is done with as much Certainty, or as much as is neceſſary, as they meaſure Land in ſurveying with a Chain, by allowing 50 Feet between each Knot, and the Glaſs to be 30 Seconds, and allowing in that Proportion, if either are more or leſs, as mentioned in the Introduction.

Hence the Longitude is found, independent of the Angle of the Courſe, by Prop. 47, *E.* 1; for the Square of the Diſtance AC is equal to the Squares of the Longitude BC, and the Latitude AB; and as the Latitude is found by the Obſervation, the Diſtance by the Log-line, and Half-minute Glaſs; hence the Longitude is given.

To give an Inſtance in Numbers. Let the Diſtance AC be 10 ſquared = 100, the Latitude AB 8 ſquared = 64, and ſubtracted from 100, remains 36; the ſquare Root is 6 or CB he Longitude; and hence the Angle of the Courſe is found by Caſe 5. of Plain Triangles, AB : R ∷ CB : T, A

AB. 0.903090 = 8
R. 10.
CB 0. 778151 = 6
9. 875061 = 36 d. 52′, the Angle of the Courſe.

But as the Diſtances cannot always be meaſured upon one Courſe, by Reaſon of contrary Winds, wherefore they have Recourſe to the Compaſs, to find the Angle, and by the ſeveral Courſes to find the ſeveral Longitudes and Latitudes; and to make one general Reckoning, which is called a Traverſe. But, There are three Difficulties which make this Angle of the Courſe uncertain to be found; which are the Variation of the Compaſs, the Lee-way of the Ship, and the Currents of the Sea; and there are two Caſes in which the Longitude and Latitude may be affected by theſe Errors: For the obſerved Latitude is either more or leſs than the imaginary one, which are the two Caſes to be corrected by this Problem; for if they are equal, the Longitude in the Traverſe is true, as anſwering to the Obſervation and Diſtance. In the firſt Caſe, when the obſerved Latitude is more than the imaginary one: Let (Fig. 2.) ADE be the imaginary Triangle, AE the Latitude, and AD the Diſtance run, and DAE the Angle of the Courſe; the Longitude DE is found by the firſt Caſe of Plain Trigonometry, or Prop. 47 *E.* 1.

But ſuppoſe, by an Obſervation, the imaginary Latitude AE is leſs than the obſerved one, which ſuppoſe to be AB; 'tis evident, according to this Diſtance, that the imaginary Courſe was taken too much, either from the Variation of the Compaſs, Lee-way of the Ship, or Currents of the Sea; for the Square of the Diſtance is equal to the Squares of the Longitude and Latitude: Hence, to make the Squares of the true Latitude and Longitude equal to that Diſtance, ſubtract the Difference BE, between the imaginary and obſerved Latitude, or DK, from the imaginary Longitude DE, making BC equal to EK; then AB and BC, the true Longitude and Latitude, are equal to AE and DE, the imaginary Longitude and Latitude, by Axiom 2 and 3 *E.* 1. and conſequently both ſquared equal to the Square of the ſame Diſtance. Hence, as the Latitude is true, the Longitude muſt be true, according to the Obſervation, and Diſtance run.

To give an Inſtance in Numbers; let AE be 6, AD 10, and hence DE is 8, by Prop. 47 *E.* 1. and becauſe the imaginary Latitude AE, or 6, is leſs than the obſerved one AB, which ſuppoſe 8, ſubtract the Difference 2, from the imaginary Longitude 8, and add it to the imaginary Latitude, and the true Latitude is 8, and Longitude 6; and both ſquared equal to the Square of the ſame Diſtance, as the imaginary Longitude and Latitude were; the Angle of the Courſe BAC is found by Caſe 5 of Plain Triangles, as mentioned before.

In the ſecond Caſe, when the obſerved Latitude is leſſer than the imaginary, let AFG, (the ſame Figure) be the imaginary Triangle, AF, the Latitude, AG, the Diſtance run, and FAG, the Angle of the Courſe by which the Longitude FG is found, by Prop. 47 *E.* 1. or Caſe 1 of Plain Triangles; but ſuppoſe the imaginary Latitude AF is more than the obſerved one, which let be AB, and to make the Squares of the true Latitude and Longitude equal to the Square of the ſame Diſtance, ſubtract the Difference BF, from the Latitude AF, and add it to the Longitude, by making BH equal to FG+FB; then AB and BH are the true Longitude and Latitude, according to the Obſervation and the Diſtance run, and by Ax. 2 and 3 *E.* 1.

To give an Inſtance of it likewiſe in Numbers; let AF be 10, FG 8, and AG 12, and as the imaginary Latitude, AF, is more than the obſerved one AB, ſubtract the Difference, which ſuppoſe 2, from the imaginary Latitude, and add it to the imaginary Longitude, it makes the true Longitude 10, and Latitude 8, and both ſquared equal to the Square of the ſame Diſtance, by Axiom 2 and 3 *E.* 1. The true Angle of the Courſe is BAH, and found as before.

The Truth of this Problem, in Practice, only depends upon theſe two mechanical Principles, of obſerving the Latitude, and meaſuring the Diſtance run, without any Regard to Currents, Lee-way, or Variation of the Compaſs: for theſe are corrected to a mathematical Certainty, by this Problem; as any one acquainted with mathematical Reaſonings may eaſily perceive.

And thus a Ship may be carried round the World, even without a Compaſs, if they can but make proper Obſervations, and meaſure a good Diſtance; and miſs no more in Longitude, or Eaſting and Weſting, as by paſſing and repaſſing the ſame Meridian, than they do in Latitude, by the Help of this Problem: For let them make an imaginary Courſe, and calculate the imaginary Triangle, and if the imaginary Latitude is more than the obſerved one, ſubtract the Difference from the imaginary Latitude, and add it to the Longitude; and if leſs, ſubtract that Difference from the imaginary Longitude, and add it to the Latitude, and this will give the true Latitude and Longitude, that the Ship is in, according to the Obſervation of Latitude, and the Diſtance run. But what is meant by finding the Longitude, by this Problem, is only the Miles of Eaſting and Weſting, from the Meridian of Departure; but to determine the Longitude in Degrees, as it is different from the Latitude, it requires a different Method; for the Lines of Latitude are parallel, but the Lines of Longitude decreaſe from the Equator, till they meet at the Pole; which makes the Miles of Longitude different in every Degree of Latitude: The Difference of Miles is found in *Mercator's* Sailing; by the Miles are meant Aſtronomical Miles of 69 + to a Degree, and theſe may be found by Proportion; for every Degree of Latitude, as 90 the whole Latitude, is to the

Square of 60, or one Degree of Longitude on the Equator :: ſo is the Complement of the Latitude to the Square of 1 Degree of Longitude, in that Latitude ; the Square Root is the Number of Miles, and dividing the Miles of Eaſting and Weſting by the Miles of 1 Degree of Longitude, if in the ſame Latitude ; but if different Latitudes, divide by the Miles of the middle Latitude, it gives the different Degrees of Longitude.

To give one Inſtance in Numbers ; the Miles of Weſting from the *Lizzard* to *Cape-Henry* in *Virginia*, are 3000, and the Miles of Longitude in the Latitude of the *Lizzard* are 39, and of *Cape-Henry* 47, which added are 86 ; the Half is 43, by which divide the 3000 Miles, the Degrees are 69, 33.

I ſhall conclude with two Inſtances of correcting in both Caſes, by which may be ſeen the Uncertainty of determining the Longitude, without the Help of this Problem, and the Hazard they muſt neceſſarily run at Sea, as it is too viſible to thoſe who have been long Voyages, by not knowing the Longitude ; and let them be in the following Traverſe.

Courſe.	Diſt.	Long.		Lat.	
		E.	W.	N.	S.
S. S. W.	50		19		46
S. W.	60		42, 5		42, 5
W. S. W.	70		64, 5		25, 8
W. by S.	60		58, 5		11
			184,4		125,3

The Weſting is 184, 4, and Southing 125, 3 Miles ; but ſuppoſe the Departure was from 50 d. and by Obſervation the Latitude was found to be in 47, 3 Degrees, or 180 Miles South ; hence, as the imaginary Latitude was too little for the obſerved one, ſubtract therefore, according to the Directions of the Problem, the Difference from the Longitude, or 54, 7 from 184, 4, and add to the imaginary Lat. there remains 129, 7, for the Long. but according to the common Way of Correction, the Longitude would have been 239, which is above 100 Miles too much, for the Obſervation of Latitude, and Diſtance run.

But in the other Caſe, to make uſe of the ſame Traverſe, ſuppoſe the Latitude, by Obſervation, had only been 1 d. 30 m. equal to 90 Miles, which is 35 Miles leſs than in the Dead Reckoning; ſubtract this from the Latitude in the Dead Reckoning, and add it to the Longitude, and the true Latitude was 90, and Longitude 219; but according to the common Way of Correction, the Longitude would only have been 149, above 70 Miles too little, for the Obſervation of Latitude, and Diſtance run. By theſe two Inſtances, it may be ſeen how uncertain and erroneous, according to the Obſervation, and Diſtance, it was to determine the Longitude by the common Way of Correction.

And a further Uſefulneſs of this Problem will appear, that if they ſhould, at Sea, unfortunately loſe their Compaſs, or ſhould it prove erroneous, if they take Care to keep a true Diſtance, which may eaſily be done, if they have no Glaſs, by telling 10 as faſt as they well can, or by the Beats of a Watch, and as many Yards as the Ship gains by telling of 10, ſo many Miles is it in an Hour; and with this Diſtance, let their Courſes be never ſo intricate, ſo as to paſs and repaſs the Meridian; yet by an imaginary Courſe, and an Obſervation, they may determine the Longitude to the ſame Certainty that the Latitude is, by following the Directions of this Problem. But Time and Experience will be the beſt Judge of the Truth and Uſefulneſs of it in Navigation. *Laus ſoli Deo.*

RICHARD LOCKE.

Expli-

Explicatio et Demonſtratio Problematis ad inveſtigandam in Navigatione Longitudinem. Authore RICHARDO LOCKE Anglo.

SI Longitudo inveſtigari potuerat per Obſervationem, ſicut Latitudo, abſque Computatione imaginaria, Anglice *Dead Reckoning*, attamen neceſſe eſſet hanc Computationem ſemper ſervare, quia Obſervationes Aſtronomicæ propter cœlum nebuloſum ſæpe pro totis ſeptimanis vix attingi poſſunt.

Imaginaria Computatio eſt Æſtimatio, ſecundum Longitudinem et Latitudinem, Navis Cursûs, per Lineam Nauticam et Clepſydram ſemimomenti, quibus Diſtantia menſuratur, et Pixidem Nauticam, qua Cursûs inveſtigatur Angulus; et ad inveſtigandam hanc Computationem Triangulum imaginarium fingunt rectangulum; Cathetus repræſentat Meridianum ſeu Latitudinis Differentiam, Baſis Longitudinem, et Hypothenuſa Cursûs Diſtantiam.

Sit ABC (Fig. 1.) Triangulus, AB Cathetus ſeu Latitudinis Differentia, BC Longitudo et AC Cursûs Diſtantia.

In hoc Triangulo, Angulus ABC factus per Latitudinem AB et Longitudinem BC, ſemper rectus erit, quicunque ſit Curſus et Diſtantia; Cathetus, ſeu Latitudo AB invenitur per Obſervationem, Diſtantia AC per Lineam Nauticam, quâ Diſtantia menſuratur in Navigatione æqua certitudine cum aliis mechanicis operationibus.

Hinc Longitudo facile invenitur independenter ab Angulo Cursûs per Prop. 47 *E.* 1. nam Quadratum Diſtantiæ æquale eſt Quadratis Longitudinis et Latitudinis; Latitudo vero invenitur per Obſervationem, et Diſtantia per Lineam Nauticam; hinc Longitudo datur.

In Numeris dabo Exemplum: Sit Diſtantia AC 10, quadrata = 100, Latitudo AB 8, quadrata 64: ſubduc 64 ab 100, remanet 36; Radix quadrata eſt 6, vel Longitudo CB, et hinc Curſûs Angulus invenitur per Caſum 5 Triangulorum Planorum, AB : R :: CB : T, A

AB 0. 903090 = 8
R. 10
CB 0. 778151 = 6
0 9. 875061 = 36 g. 52′, Angulus Curſûs.

At vero cum Diſtantiæ non ſemper menſurantur per unum Curſum, propter ventos contrarios; hinc per Pixidem Nauticam, Angulum Curſûs obſervare neceſſe habent, et per varios curſus inveniunt varias Longitudines et Latitudines, et hinc tota Diſtantia inveſtigatur; quod dicitur Curſus Obliquus, Anglice *Traverſe*.

Tria autem ſunt impedimenta, quæ hunc Angulum incertum reddunt; ſcilicet, Variatio Pixidis Nauticæ, Navis Declinatio, et Fluxus Maris.

Et duo ſunt Caſus, quibus Longitudo et Latitudo, per hæc impedimenta, incerta redduntur; aut enim Latitudo in Obſervatione major eſt, aut minor quam Latitudo imaginaria.

Si Latitudo Imaginaria eſt minor quam Latitudo obſervata, ſit ADE (Fig. 2.) Triangulus imaginarius, AE Latitudo, AD Diſtantia, et DAE Angulus Curſûs: Longitudo, DE, invenitur per 1 Caſum Tri. Plan. aut per Prop. 47 *E.* 1. At ſi per Obſervationem, Latitudo AE inveniatur minor quam Latitudo obſervata, quæ ſit AB, et inde, ut Quadrata Longitudinis et Latitudinis ſimul ſint æqualia Diſtantiæ Quadrato, ſubduc Differentiam EB inter imaginariam et veram Latitudinem, à Longitudine ED, et adde Latitudini AE; hinc AB eſt vera Latitudo,

titudo, et EB vera Longitudo, et utraque Quadrata ſimul æqualia Diſtantiæ Quadrato, per Ax. *E.* 2. Pro exemplo in Numeris, ſit AE 6, AD 10, et hinc DE eſt 8 per Prop. 47 *E.* 1. Subduc 2 Differentiam à Longitudine Imaginaria 8, et adde Imaginariæ Latitudini 6, hinc Latitudo vera eſt 8, et Longitudo 6, et utraque Quadrata æqualia Quadrato Diſtantiæ. Q. E. D.

In ſecundo Caſu, ſit FAG Triangulus imaginarius, AF Latitudo, AG Diſtantia, et FAG Angulus Curſûs, per quem Latitudo, FG, invenitur, per Caſum 1 T. P. aut per Prop. 47 *E.* 1. Sit vero Latitudo imaginaria, AF, major quam Latitudo per Obſervationem, quæ ſit AB; hinc ut Quadrata Longitudinis et Latitudinis ſimul ſint æqualia Quadrato Diſtantiæ, ſubduc Differentiam BF, à Latitudine AF, et adde Longitudini FG, et vera Latitudo eſt BG, et Longitudo BH; nam utraque Quadrata ſimul ſunt æqualia Quadrato Diſtantiæ, per Ax. *E.* 2.

Pro Exemplo in Numeris, ſit AF 10, FG 8, et AG 12. Subduc 2 Differentiam, ab imaginaria Latitudine, et adde imaginariæ Longitudini, vera Longitudo erit 10, et Latitudo 8, et utraque ſimul Quadrata æqualia Quadrato Diſtantiæ, et Angulus BAH inventus eſt ut prius.

Veritas practica hujus Problematis in Navigatione, dependet ſolum in has duas mechanicas operationes, ſcilicet, obſervare Latitudinem et Curſûs Diſtantiam menſurare; nam Variatio Pixidis Nauticæ, Navis Declinatio, et Maris Fluxus, per hoc Problema, mathematica certitudine corriguntur; ut facile pateat omnibus Demonſtrationem inquirentibus, et ſic Navis feratur per totum mundum, abſque Pixide Nautica, per veram Obſervationem et Diſtantiam; nam fac Curſûs Angulum imaginarium, et ſi Latitudo imaginaria eſt major quam obſervata, ſubduc Differentiam a Latitudine et adde Longitudini; ſi vero minor ſit, ſubduc Differentiam a Longitudine, et adde Latitudini, et in utroque Caſu dabit veram Longitudinem et Latitudinem, ſecundum Diſtantiam et Obſervationem. *Laus Deo.*

Exegi Monimentum ære perennius.

RICHARDUS LOCKE.

FINIS.